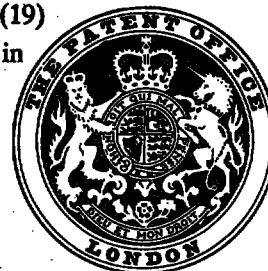


PATENT SPECIFICATION

(11) 1 523 947

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- (21) Application No. 32717/76 (22) Filed 5. Aug. 1976 (19)
 (31) Convention Application No. 50/108816U (32) Filed 6 Aug. 1975 in
 (33) Japan (JP)
 (44) Complete Specification Published 6 Sep. 1978
 (51) INT CL² H01J 63/06
 G09F 9/32
 (52) Index at Acceptance
 H1D 34 4A4 4A7 4E1 4E4 4F2A 4F2Y
 4K10 4K2A 4K2C 4K2Y 4K3B 9A 9C2
 9CY 9D 9Y
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 (54) LIGHT-EMITTING VACUUM DISPLAY
 TUBE



(71) We, NIPPON ELECTRIC CO., LTD., of 33-1, Shiba Gochome, Minato-ku, Tokyo, Japan; and NIPPON ELECTRIC KAGOSHIMA, LIMITED of 12699, Takemoto, Izumi-shi, Kagoshima, Japan; both Japanese companies, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:-

This invention relates to a light-emitting display tube with an improved cathode support.

A fluorescent or phosphorescent vacuum display tube comprises in a vacuum envelope a substrate assembly comprising, in turn, a substrate of an electrically insulating material and a plurality of luminescent anode segments thereon. Each anode segment may be recessed into the substrate. The tube further comprises at least one elongated hot cathode over the anode segments and one or more grids between the cathode and the anode segments. In a vacuum display tube for displaying a plurality of selected numerals, letters, or other symbols at a time, the anode segments are provided in groups for the respective symbols with the cathode either extended over all the anode segment groups or lengthwise separated into a few portions, each over some of the groups; and with a grid provided in general for each group. In many single-digit or multi-digit tubes, use is made of a pair of cathode supports attached to the substrate in order to keep the or each cathode under tension therebetween and of a pair of cathode spacers near both ends of the cathode in order to keep a predetermined spacing between the cathode and one or more related grids as will later be illustrated with reference to one of the Figures of the accompanying drawing. This requires a relatively wide space at each cathode end, gives

rise to tensions of different magnitude from tube to tube, tending to contribute undesiredly to snapping of the cathode and resulting in loss of the cathode heating power.

It is, therefore, an object of this invention to provide an improved light-emitting vacuum display tube in which the chance of snapping of the cathode is reduced and the power required to heat the cathode to a predetermined temperature is reduced and manufacture of the tube is simplified.

According to this invention, there is provided a light-emitting vacuum display tube comprising in a vacuum envelope a substrate assembly having a plurality of luminescent anode segments on a substrate of an electrically insulating material, a hot cathode, and a grid between the anode segments and the cathode, wherein the cathode is tensioned between two unitary supports which not only support the cathode but establish the spacing thereof from the substrate and hence from the grid.

The invention will now be described, by way of example, with reference to the accompanying drawing in which:-

Figure 1 shows a perspective view of a general light-emitting vacuum display tube with parts cut away;

Figure 2 shows an enlarged schematic partial side view of a cathode support and a cathode spacer of a conventional vacuum display tube together with related elements thereof;

Figure 3 shows a schematic perspective view of a unitary cathode support-spacer used in a vacuum display tube according to an embodiment of this invention together with a pair of hot cathodes of the tube; and Figure 4 is a schematic side view of that portion of the tube shown in Figure 3 which corresponds to the portion illustrated in Figure 1.

Referring at first to Figure 1, a lumines-

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cent display panel, namely a light-emitting vacuum display tube of a flat type, comprises a substrate assembly 20 comprising, in turn, a substrate 21 of an electrically insulating material, such as a glass or ceramic, a plurality of luminescent anode segments 22 on the substrate 21, and a plurality of conductive leads 23 also on the substrate 21. In the example being illustrated, the anode segments 22 are arranged in a substantially figure-of-eight configuration and in a plurality of groups, each for a selectable one of the numerals 0 to 9. The substrate assembly 20 further comprises on the substrate 21 a pair of cathode seats 25 connected to two of the leads 23, respectively, and a plurality of pairs of grid seats 26, each pair being for an anode segment group and connected to one of the leads 23. A grid 28 is attached to each pair of the grid seats 26 to cover a relevant one of the anode segment groups. At least one hot cathode 29 is extended over the grids 28 between a pair of cathode supports (not shown in Figure 1) attached to the respective cathode seats 25. The substrate assembly 20 with the grids 28 and the cathode 29 held thereby is hermetically sealed to a glass cover plate 30 by means of an intermediate thin layer of fused frit of a low melting point, such as 600°C, with the anode segments 22, the grids 28, and the cathode 29 disposed in a hermetically sealed space. As shown, the conductive leads 23 extend outwardly of the sealed space to serve as external leads 31 for supplying a cathode heating power and a cathode potential to the cathode 29 and for selectively supplying a grid voltage to the grids 28 and also the anode segments 22 with a potential that is positive with respect to the cathode potential. As is known in the art, the substrate assembly 20 may be enclosed with a vacuum bulb (not shown) with the grids 28 and the cathode 29 held by the substrate assembly 20, instead of hermetically sealing the cover plate.

Turning to Figure 2, a conventional form of the cathode supports 36 is attached to one of the cathode seats 25 of the substrate assembly 20 which is enclosed in a vacuum bulb (not shown). In the illustrated example, it should be understood that the cathode seats 25 are formed on the back of the substrate 21. The ends of the cathode 29 are welded to respective supports 36, with the supports 36 manually inwardly bent but sprung outwardly so as to give a tension to the cathode 29. Two spacers 37 are put between the respective end portions of the cathode 29 and the substrate 21 to provide a predetermined spacing between the cathode 29 and the substrate and hence between the cathode and the grid 28. This requires space at the cathode or substrate end portions. In addition, the spacers 37 give rise to snapping

of the cathode 29 due to the rubbing there-against of the cathode 29 during repeated heating cycles of the cathode 29 resulting when the cathode heating power is turned on and off. The power is partly wasted in heating the spacers 37. Manual bending of the supports 36 during the welding process results in unavoidable fluctuations in the tension given to the cathode 29.

Referring to Figures 3 and 4, a unitary cathode support-spacer 40 for use in a luminescent display tube according to an embodiment of this invention comprises a first transverse member 41 having at least one lug 42 to be welded or otherwise fixed to one of the cathode seats 25, at least one post 43 integrally attached at one end to one end portion of the transverse member 41 and extending substantially perpendicularly of the latter, and a second transverse member 44 integrally extending from the other end of the or each post 43 in a cantilever fashion and provided with a tab 45 at the free end. It will be understood in conjunction with the sample clearly shown in Figure 3 that the illustrated support-spacer 40 is for a pair of cathodes 29 and that two cathode seats (not shown in Figures 3 and 4) are formed along a conductive lead 23 instead of one 25 as depicted in Figure 1. Preferably, each cathode 29 is provided with a tab at each end, each of which tabs is welded to the corresponding tab 45 of a support-spacer 40. It is preferred to manufacture such support-spacers 40 from a metal sheet by punching and pressing. The spacing between the cathode 29 and the grid 28 is determined by the distance between the lug 42 and the tab 45. The tension given to the cathode 29 is substantially decided by the length and width of the second transverse member 44. The support-spacer 40 dispenses with the space required to accommodate the separate spacers 37 and with the friction between the cathode 29 and the spacers 37. Loss of the cathode heating power is appreciably reduced. Furthermore, it is possible to simplify the processes of manufacturing light-emitting display tubes.

The support-spacer 40 can be modified in various ways. The post 43 preferably has an integral reinforcing flange 46 and may form an angle with the transverse members 41 and 44. The latter members 41 and 44 need not be parallel. These members and the post 43 may have short extensions (not shown). The tab 45 is preferably integral with the second transverse member 44 and may extend outwardly therefrom with respect to the cathode 29. This applies also to the lug 42. If extended substantially parallel to the first transverse member 41, the second transverse member 44 may have a pair of tabs, such as 45, at the free end portion for a pair of cathodes 29. The lug 42 may be

directly fixed to the substrate 21 without the use of the seat 25 therefor but with connection to a conductive lead, such as a lead 23 illustrated with reference to Figure 1.

5 WHAT WE CLAIM IS:-

1. A light-emitting vacuum display tube comprising in a vacuum envelope a substrate assembly having a plurality of luminescent anode segments on a substrate of an electrically insulating material, a hot cathode, and a grid between the anode segments and the cathode, wherein the cathode is tensioned between two unitary supports which not only support the cathode but establish the spacing thereof from the substrate and hence from the grid.

2. A display tube according to claim 1, wherein each unitary support comprises integral portions consisting of a first transverse member on the substrate, a post extending from the transverse member transversely with respect thereto, and a second transverse member extending from the post in a cantilever fashion and having a tab at its free end portion to which is welded an end of the cathode.

3. A display tube according to claim 2, wherein an extension from the free end of the second transverse member is bent inwardly with respect to the cathode to provide the tab.

4. A display tube according to claim 2 or 3, wherein the unitary support further comprises an integral lug extending from the first transverse member inwardly with respect to the cathode and fixed to the substrate.

5. A display tube according to any one of claims 2 to 4, wherein the unitary support is a punched and pressed sheet metal part.

6. A display tube according to claim 5, wherein the post has an integral reinforcing flange.

7. A display tube according to any one of claims 2 to 6, wherein the first and second transverse member are substantially parallel to each other.

8. A display tube according to claim 7, wherein the second transverse member further has an additional tab extended from the free end portion thereof in the same direction and sense as the first-mentioned tab for welding thereto of an end of an additional hot cathode.

9. A light-emitting vacuum display tube substantially as hereinbefore described with reference to, and as illustrated in, Figures 3 and 4 of the accompanying drawing.

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5 WHAT WE CLAIM IS:-

1. A light-emitting vacuum display tube comprising in a vacuum envelope a substrate assembly having a plurality of luminescent anode segments on a substrate of an electrically insulating material, a hot cathode, and a grid between the anode segments and the cathode, wherein the cathode is tensioned between two unitary supports which not only support the cathode but establish the spacing thereof from the substrate and hence from the grid.

2. A display tube according to claim 1, wherein each unitary support comprises integral portions consisting of a first transverse member on the substrate, a post extending from the transverse member transversely with respect thereto, and a second transverse member extending from the post in a cantilever fashion and having a tab at its free end portion to which is welded an end of the cathode.

3. A display tube according to claim 2, wherein an extension from the free end of the second transverse member is bent inwardly with respect to the cathode to provide the tab.

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